explicit declaration hitherto known in favour of introducing such a correction was contained in a letter from Kepler to Bernegger of June 30, 1625 ("Op. Omnia," t. vi. p. 618). It now appears, not only that the conclusion was an entirely original one, but that he had arrived at it twenty-six years previously. M. Anschütz promises some further elucidations of the point, which we await with interest.

One of the most curious chapters in Kepler's mental history is furnished by his attitude towards the astrological superstitions of his time. Herwart, as a good Catholic, had condemned them; his correspondent made out a case in reply. His contention, it is true, was not on behalf of the vulgar charlatanry of the science. This he admitted to be indefensible, save on the one poor plea of stringent necessity. Providence, as he wrote to Maestlin, which had denied to no animal the means of preserving its life, had assigned, for that end, astrology to the astronomer. He must draw horoscopes and publish prophesying calendars, or cease to exist. Thus only could he obtain means to pursue nobler studies. The people, while giving their money for the lies they loved, unconsciously promoted the truth they were indifferent to. It was an involuntary, but none the less efficacious, "endowment of research."

So Kepler filled his empty pockets, and satisfied his conscience by professing incredulity in his own vaticinations. They proved, nevertheless, and, as it were, in his own despite, highly successful. Not a few of them stumbled felicitously into fulfilment. Some art, or luck, drew them, now and again, into conformity with the future. And since, as their author himself remarked, the game is one in which the hits count, but the misses are forgotten ("Das Treffen behält man, das Fehlen aber vergisst man") his reputation as a seer rose high, and brought him in the best and only sure part of his income.

There was, however, a recondite species of planetary influence believed in by Kepler as part of the eternal order of things. By the belief, indeed, his whole career of investigation was profoundly influenced; for the effort to justify it led him into a track of thought which finally conducted him to the Third Law. One of the chief points of interest in the present correspondence is that it discloses the time and manner of his entrance upon that track. "Lift up your ears to listen: Eureka!" he wrote to Maestlin, August 29, 1599; and to Herwart, August 6, he solemnly announced his invention of a "theorema jucundum," in which was concentrated the whole secret of the music of the spheres. Already he gives the title ("de Harmonia Mundi"), and, to a certain extent, the plan, of the great work published twenty years later. It was conceived, as we now see with additional clearness, less under the influence of sober truth-seeking, than in the fervour of illusive speculation. Essentially, it was a piece of brilliant extravagance. That the harmonic law of periods and distances should have been found as a nugget amid such worthless, though shining debris, is one of the oddest facts in the history of science.

The theory of planetary harmonies was struck out by Kepler as an adjunct to his peculiar theory of planetary aspects. It might in fact be called its dynamical counterpart. Geometrical relations of movement were substituted in it for geometrical relations of position. The velocities of the six planets were, he averred, so connected that, were there an inter-planetary medium capable of conveying audible vibrations, a celestial chord of the sixth and fourth would perpetually resound through space. The intellectual perception of potential harmonies sufficed, however, for the delectation of the rational creatures appointed to enjoy them; while, similarly, the intellectual apprehension of "aspects" affected, primarily, the sentient "soul of the world," and, secondarily, through the varying moods thus impressed by the stars, the course of sublunary affairs. The third letter to Herwart is mainly filled with details of Kepler's persevering efforts to complete and fortify the visionary analogy between astrological aspects and musical intervals.

Yet even here, in this region of intangible speculation, his innate respect for facts did not desert him. What autobiographical details he left, we owe to his desire to compare his life as it was with what, astrologically, it ought to have been. And the first of the present letters contains a highly curious little bit of self-study, illustrative of the depressing effects of "Saturn in sextile with the Sun" at the hour of nativity. Here is Kepler described by himself, ætat. twenty-seven.

"A body of no ample proportions, lean and scraggy; a mind unaspiring, that is to say, burying itself in literary nooks and crannies, suspicious, timid, tending towards, and abiding in difficulties and knotty points; manners to correspond. Sour and sharp flavours, the gnawing of a bone, the devouring of dry bread, form my gustatory delights; my keenest ambulatory joy is to traverse steep and rugged paths, to mount hills, to pierce my way across dense thorn-brakes. Pleasure in life other than in study I neither have nor desire; proffered, I reject. My fortune matches my tastes to a hair. Where others might abandon hope, I find access to achievement and fame. Yet not over spacious; for my advance is continually checked, and my circumstances change without mending. All my efforts have hitherto met with strenuous resistance. It may be that social sympathy will ever be denied me while I irritate mankind by advocating the movement of the earth, while

"tanti ponderis orbem
Obnixa cervice cito per sidera lapsu
Incito, terricolûm contra nitente senatu."

A. M. CLERKE

UPLAND AND MEADOW

Upland and Meadow, a Poaetquissings Chronicle. By Charles C. Abbott, M.D. (London: Sampson Low, Marston, Searle, and Rivington, 1886.)

THIS is a very pleasantly written book by an author who may be justly regarded as a kind of American Gilbert White. We may as well inform our readers at once that the district of which the natural history is herein chronicled is situated by a little stream which empties itself into the River Delaware, and that the name, which will appear to English readers somewhat difficult of pronunciation, is of Indian origin. There are fourteen chapters in the work, and an index which is to be strongly commended for its completeness. It is really a most important feature in a book of this kind to have a good index, and in insisting upon this necessity we are intentionally paying a complimentary tribute to the

author, because there is a large amount of valuable observation which readers should have occasion to refer to after the first perusal of the work, but which would be lost without such an index, owing to the necessarily disjointed mode of treatment entailed by an adherence to seasonal records. We need only refer to the early editions of Kirby and Spence's "Introduction to Entomology" as an example of a work containing a large collection of facts and observations rendered almost useless for want of an index.

Dr. Abbott is evidently a close observer, and English naturalists will derive both pleasure and profit by a perusal of his chronicle. It is rather to be regretted that he has confined himself so much in the text to the local trivial names of the animals and plants of his district. It places English readers at a disadvantage, for example, to have to turn to the index each time a species is mentioned in order to find out what is referred to under such names as "grakles," "quaker-girls," "quahog," or "scuttle-bug." But this is, after all, a matter of small importance, because the scientific names will be found in the index, and the criticism is made only on behalf of that large circle of readers in the old country which the work ought to attract, and to which it appeals through its English publishers.

The author's strong point appears to be ornithology, but his sympathies are fairly distributed, and his observations are recorded in a pleasant, chatty style which is sure to be attractive to general readers :—

"To realise what a wealth of animal and vegetable life is ever at hand for him who chooses to study it, let a specialist visit you for a few days. Do not have more than one at a time, or you may be bewildered by their enthusiasm.

"I have had them come in turn—botanists, conchologists, microscopists, and even archæologists. What an array of names to strike terror to the breasts of the timid; yet they were all human, and talked plain English, and, better than all, were both instructive and amusing."

As a specimen of the author's style we give the following from Chapter II., entitled "Poaetquissings in Winter."

In order to carry on observations without frightening the denizens of the creek, the author was in the habit of lying down upon the ice, covered over with a blanket so as to be able to see into the frozen depths. The terrestrial life soon became accustomed to his presence, and at length became inquisitive. "This was amusingly illustrated in one instance by a weasel, in crossing the creek on the ice, stopping to investigate the peculiar something lying in its path. Peering under the blanket, it either heard my blood circulating or smelled it. At all events it gave my ankle a nip which brought me quickly to my feet, and sent the bloodthirsty wretch scudding over the ice with marvellous rapidity. How the crows laughed! I had noticed a flock of these birds when I went to the creek, and had been wondering if their incessant cawing was not a discussion of my curious movements. They were, possibly, disposed to think me a trap laid for them, but were astonished or amused at my sudden regaining of the perpendicular when the weasel offered to investigate the matter."

In the third chapter, "Twixt Cold and Heat," will be found a good collection of observations and experiments bearing on the subject of instinct, with special reference to the nesting of birds. Whether the author's views on this much-vexed question will command assent we cannot undertake to say, but whether we differ from his conclusions or not, his experiments are certainly worthy of serious consideration. Among these we have a series of experiments with a chromo-picture of a cat, with a mirror, and with coloured yarns, the latter having for their object the testing of the sense of colour. In the case of a Baltimore oriole in course of building its nest, a decided choice was exerted—red, yellow, purple, and green yarns having been refused, and gray only selected, till the nest was nearly finished, when a few of the purple strands were used. Other amusing experiments on the transference of eggs are described in this same chapter.

With reference to the subject of migration the author states in Chapter IV., on "Marsh Wrens," that "temperature and migration are largely coincident, but cannot be considered as cause and effect." He further adds that certain rules respecting the habits of American birds which had been regarded by previous observers as fixed and invariable, are quite variable if observations are only continued over a sufficiently long period of time. "The results of a single year will have but little bearing upon the regularity or want of it in a bird's movements. The observations of the same person in the same locality must extend over at least a decade before it is safe to arrive at any general conclusions." We commend this passage to the members of our county field clubs who are in want of material for observation.

Space will not permit us to make any lengthy extracts from the book, but we cannot refrain from calling the attention of the bird-destroyers of this country to the admirable "apology" for the grakle (*Quiscalus versicolor*) which the author makes in the fifth chapter. These birds were formerly regarded as enemies to agriculture, owing to their habit of feeding upon ripe grain, which led to their being dubbed by the unpopular name of "maize thieves." But, according to Dr. Abbott's observations, it is at least doubtful whether, on the whole, man does not profit more by the existence of these birds than is lost by the attack upon the grain. To get an idea of the amount of insect food consumed by a pair with five young, he observed the birds for two hours (10 to 11 a.m. and 2 to 3 p.m.), during which time thirteen trips were made by each bird, each returning with an insect every time. The young thus got a "square meal" at least every ten minutes. The feeding goes on for ten hours per diem till the young are twenty-five days old, when they leave the nest, so that during this period each young bird has been supplied with 1300 insects, or 6500 altogether. The eleven nests in the colony under observation were supplied, therefore, with 71,500 insects, and as seven pairs in the colony raised second broods, a further supply of about 45,500 insects was "requisitioned," thus bringing up the total number consumed by one colony of birds to the enormous total of 117,000, or, including the food of the parent birds, about 150,000 "forms of insect life destroyed, all of which would have proved more or less destructive to the growing crops." We hope that the lesson taught by this observation will not be lost upon those who fail to see in persecution by birds a sufficient

cause for the marvellously perfect cases of adaptive resemblance so common among insects.

Apropos of the extermination of plants, Dr. Abbott remarks (p. 41) with respect to the witch-hazel (*Hamamelis virginica*):—"Bent twigs of this plant are still used by the 'gifted' to find water, lost farming tools, and, by one enthusiast, Indian graves. The faithful still claim it as efficacious, and he who doubts is sneered at if he expresses his opinion. All that the rambler can ask is that the plant be not exterminated, and that the fools may be." We may perhaps echo this sentiment on this side of the Atlantic without offence to the members of "Primrose" or any other floral "Leagues." A protest against the extermination of rare plants by "dealers" was circulated by the Corresponding Societies Committee of the British Association last year.

We have given a sufficient idea of this work to commend it to the notice of English naturalists, and we may remark in conclusion that, although the animals and plants referred to are not familiar to the ramblers by our own streams, the sparkling anecdotal style will cause the volume to be enjoyed by all, whether trained observers or casual country wanderers, and the spirit in which the author goes forth into the fields and woods or saunters by his favourite "Poaetquissings" may be well imitated by the numerous field naturalists now being called into activity by the widely-spread establishment of local societies. "He who has this interest in the life about him can never be lonely, wander wheresoever he will, nor return from a contemplative ramble other than a wiser and happier man." R. M.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

On Refractometers

I OBSERVE that in your issue of June 17 (p. 157) there is an article by Mr. Gordon Thompson on "The Determination of the Index of Refraction of a Fluid by Means of the Microscope." The method there described was, I believe, first proposed by the Duke de Chaulnes in 1767; and in 1876 was suggested by Dr. Royston Pigott in connection with his refractometer. It was employed in 1878 by Dr. Sorby for recognising the minerals in thin slices of rocks; and in 1884 by Dr. Bleekrode in determining the refraction of liquefied gases (*Proc.* Royal Society, vol. xxxvii. p. 343). In these two instances the ordinary method was unavailable. The proposed method has not been much used owing to the fact that the index of refraction cannot be at all depended upon beyond the third place of decimals.

Mr. Thompson considerably exaggerates the difficulty of the usual method by means of a hollow prism: the angle of the prism may be determined once for all; the position of minimum deviation presents no difficulty; and the use of monochromatic light is unnecessary. Indeed it would be objectionable, as it would prevent the determination of the dispersive power, which is often of equal importance with the refractive power of the substance. In my own experiments I have often taken observations both of the refraction and dispersion of five or six liquids during the course of an hour, including the cleaning of the prism between each.

The suggested method seems scarcely to admit of determining the temperature of the drop with any accuracy, which is an important matter where liquids are concerned. It may, however, doubtless be employed by those who have a good microscope, where great accuracy is not required.

There is an instrument called Abbe's refractometer, which I have recently used for preliminary determinations, and I find it gives accurate results to the third place of decimals. It is founded on the principle of total reflection. It requires also only a drop of the liquid, and as the index of line D is read off without any calculation a complete determination can be made in a minute or two. There is also an arrangement by which the dispersion D to F can be observed and calculated, but I do not find that this is accurate enough to be of much service. The instrument is to be obtained of Carl Zeiss of Jena.

17, Pembridge Square, June 26 J. H. GLADSTONE

Luminous Boreal Clouds

DURING the past two or three years what appears to the writer a distinct class of luminous night clouds in the north sky have occupied his attention. They have probably not escaped more competent observers, and been perhaps referred to simple auroral phenomena, thus escaping discussion. A very marked example was visible here the night before last (22nd inst.), of which inclosed is an illustration from a sketch at the moment.

I may premise the sky was generally clear, stars bright, temperature very low, and wind strong (N.B.) from north-west—a direction maintained for the past two days. Only a slight degree of illumination was imparted to the clouds by a low moon in the south-east, near last quarter. Some light cirrus "scud," high up, conformed to direction of wind.

Above and behind a dark but very limited bank of stratocumulus, a luminous cloudlet of brilliant pearly lustre appeared, not concurrent exactly with either the magnetic or true meridians, in altitude from 5° to 10° from the horizon, and for 7° in horizontal arc. Its shape, character, and position little varied during observation from 11.30 p.m. to 2 a.m. The structure in this case (only partially realised in the sketch) was striated, the "strike" of main streaks being north-east and south-west. *Transverse bars of luminosity conformed closely to the direction of the cirrus clouds above, and of the wind.* On the three or four other occasions of such observations these luminous cloudlets have been devoid of structure, but in every case they have presented, as in this, an opaque pearly lustre, with definite outline.

Of an entirely different type to the eye are the sudden, diffuse, variable, and transient transparencies of auroræ. Avoiding premature discussion, one cannot but suspect the former occur in much lower and less rare sky-tracts probably than the latter, with a possible frictional factor in their development; and might be distinguished as *nubiculæ borealis* if accorded a special place on further observation. The temperature has been keeping low, and sunset after-glows have in some degree reappeared during the past week; especially gorgeous being the cloud-tints at sunset of the 22nd inst. D. J. ROWAN

Dundrum, co. Dublin, June 24

Ampère's Rule

WITH regard to Ampère's rule I should be glad to know what is the general experience of actual teachers?

I have taught electricity to boys for four years, and when at Rugby I learned the subject for I think two years. My experience has been that "Ampère's rule" is *not* confusing; and as a teacher I find it best to give both this rule and the "screw-motion" rule. I see that Mr. Cumming gives both, on p. 222 of his book. W. L.

The College, Cheltenham

AS Prof. Daehne (NATURE, June 24, p. 168) has called attention again to the treatment of Ampère's rule in my "Electricity Treated Experimentally," perhaps you will allow me to point out that the rule given by Ampère is quoted *historically* only, and for it is substituted a rule, due, I believe, to Clerk-Maxwell, which seems to me preferable to either the original rule of Ampère, or to that quoted by Prof. Daehne, namely, that the movement of a north pole is right-handed to the direction of the current. That is to say, if we assume any right-handed screw to be propelled along the current, the north pole will move in the direction of the twist in the muscles of the wrist in propelling it; and *vice versâ*, if the north pole move in